DOCUMENT RESUME

ED 372 209 CE 066 805

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TITLE Factors Related to the Learning of Participants in the Ohio Pesticide Private Applicators Instructional Program. Summary of Research 77.
INSTITUTION Ohio State Univ., Columbus. Dept. of Agricultural Education.
PUB DATE 94
NOTE 9p.
PUB TYPE Reports - Research/Technical (143) -- Information Analyses (070)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Achievement; Adult Education; *Adult Farmer Education; *Adult Learning; Cognitive Development; *Cognitive Measurement; Educational Research; *Extension Education; *Pesticides; Student Evaluation

ABSTRACT

A study determined the learning (achievement) of 151 participants in the 1992-93 Ohio pesticide applicator training (PAT) program. It assessed the intended level of cognition of instruction and the actual cognition level achieved by the participants. All participants were pre- and posttested using questions adapted from Hall and Prochaska (1991), Environmental Protection Agency (EPA) Home Study Course (1980), Ohio PAT program (Bohmont 1990), and information in the core package used by the program. The interview schedule developed by Bhardwaj (1989) was used to collect data that measured the intended level of cognition at which the PAT instructors planned to deliver the program. Findings indicated that the county agricultural agents who participated in the study intended to deliver the program primarily at the remembering (25 percent) and evaluation (21 percent) levels. The participants learned primarily at the remembering level. The following recommendations were made: county extension agents should become familiar with the levels of cognition; the Ohio Cooperative Extension Service should hire candidates who have knowledge of cognition; staff of the Ohio Department of Agriculture should attend workshops on developing tests for higher cognitive levels; and the EPA should include cognitive levels in the PAT program. (Contains 21 references.) (YLB)

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Summary of Research

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ED 372 209

Factors Related to the Learning of Participants in the Ohio Pesticide Private Applicators Instructional Program

Daniel Okoro and Larry E. Miller

In recent years, research in extension education has moved from emphasis on information dissemination to a focus on adult learning and cognition (Cano, 1988; Bhardwaj, 1989; Ismail, 1992, Thomas and Anderson, 1991; and Miller, 1992). The Agrichemical Age magazine, in a June and July 1988 article entitled "Barely Passing", noted the growing concern about the quality of training occurring in pesticide training programs (Miller, 1992).

While farmers are seeking ways to improve their production efficiency by wise use of pesticides, the challenge to agricultural educators, including the Cooperative Extension Service (CES), is to respond to the complex changes and widespread use of pesticides. Participants in pesticide applicator training (PAT) programs should receive adequate and comprehensive instruction in the safe use of pesticides through expansion or improvement of pesticide applicator educational programs (National Task Force, 1988).

Thomas and Anderson (1991) and Henderson (1988) observed the paucity of research on cognition levels in educational programs conducted by the CES and suggested that the design of adult educational programs should include consideration of the levels of cognition in order to provide an adequate knowledge base in years ahead. Henderson suggested that extension should teach its clientele how to further develop, use, and improve their cognitive skills in order to become better thinkers, problem solvers, and decision makers (1988).

Newcomb & Trefz (1987) indicated that the remembering level of cognition involves the ability to memorize and recall simple, concrete facts, definition, dates and no understanding of the concepts or principles of the information provided is required. The processing level of cognition involves the use of known facts, principles, theories, and application of understood information to new and unique situations. The creating level of cognition involves the ability to combine pieces of information in a form that is new to the student, The creating level provides the opportunity for independent thinking and self-expression. The evaluating level involves the ability to make a judgement or critical evaluation, for a given set of information, that is based on a standard or specific criteria.

One of the principal concerns of those involved in PAT is the extent to which learning is occurring. While many states test participants at the end of PAT programs with formal examinations as a criterion for issuing a certificate, the level of learning (cognition) occurring has not been established. This problem is exacerbated by the fact that the instructors, as employees of the CES, are often not involved in developing the examinations (Miller, 1992).

Moody (1990) suggested that if Extension expects to meet the challenges of increased use of pesticides, it has to maintain the momentum of change. Extension needs to expand research into the variety of possible delivery structures, types of curricula and instructional methods to adequately respond to the rapid increase in the use of pesticides and their possible side-effects on human and animal health.

The fact is that after more than 16 years of PAT programs in Ohio, several cases of poisoning,

warnings and criminal actions occur annually (ODA Reports on Pesticide Use Investigation, 1991 and 1992). This illustrates that the goals of prevention have not been achieved as might have been expected. Therefore, evidence needs to be gathered about the learning which is occurring in the PAT program in the core areas.

Core, here, refers to the basic knowledge and skills in pesticide application to be acquired by applicators before obtaining a certificate. Every private applicator should be initially trained in the core (basic and essential information common to all pesticide use operations) elements of pesticide application and in specific knowledge related to the restricted pesticide that they will need to protect livestock and crops. Content in the core program provides education in:

1. Recognition of common pests encountered in the particular farm operation.
2. Understanding the principles and recommendations for pest management and control related to the farming operation.
3. Familiarity with and understanding of labeling.
4. Understanding the principles of correct application.
5. Recognition of poisoning symptoms and the procedure for medical aid.
6. Procedures for storage and disposal.
7. Personal protection.
8. Recognition of local environmental situations.
9. Legal responsibilities.

Purpose and Objectives

The purpose of this study was to determine the learning (achievement) of the participants in the Ohio private PAT program by assessing the intended level of cognition of instruction and the actual cognition level achieved by the participants in the training program. The following objectives were developed to guide the study:

1. Determine the intended cognitive levels of instruction in the PAT program.
2. Determine the prior knowledge of participants in the core area.
3. Determine the actual cognitive levels achieved by participants in the core area.
4. Determine the learning of participants in the core area.
5. Determine the relationship between the learning of the participants and other variables.

Methodology

Population and Sample

The target population for this study consisted of the participants in the 1992/93 Ohio PAT program. The accessible population for this study consisted of all the participants in seven counties of Ohio who self-selected to participate in the study (N = 151).

Design of the Study

A descriptive ex post facto design was employed for the study. The study can not be considered a true experimental design because subjects who participated in the PAT program self-selected by enrolling and, moreover, the variables were already naturally occurring or self-selected by subjects. Figure 1 reveals a model of the dependent variable, the main independent variables, and the rival or alternative variables investigated.

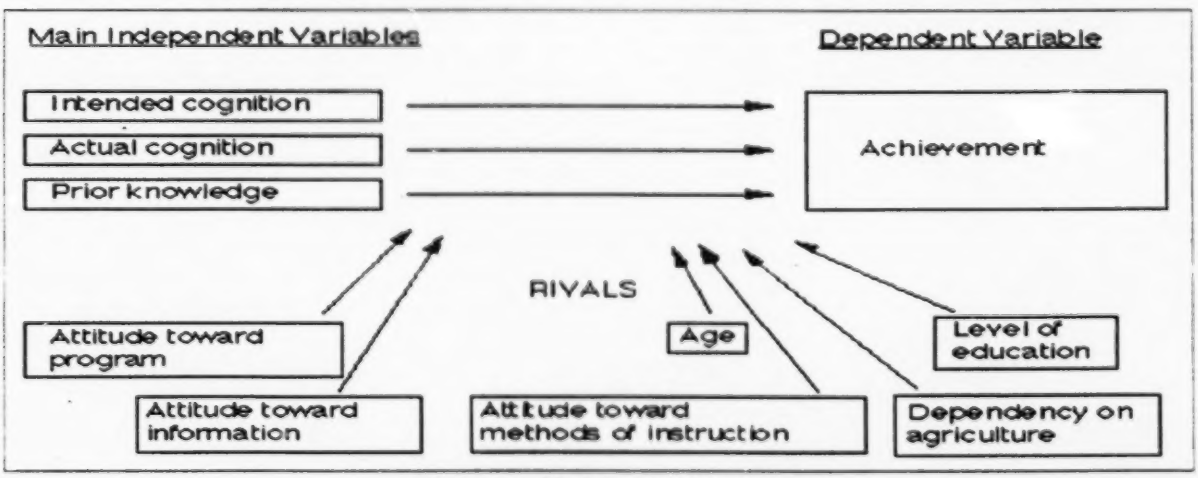

Figure 1. Model to be Investigated.

All the participants were pretested at the beginning of the training and posttested after they completed the training program. Demographic data were collected to determine the background of the participants.

Instrumentation

The pretest and posttest questions used to measure the impact of the training and instruction on achievement at the remembering level of cognition of participants were adapted from Hall and Prochaska (1991), the EPA Home Study Course (1980), and modified to suit this study. The pre- and posttest questions used in this study for measuring the impact of the training and instruction on achievement at the processing, creating and remembering levels of cognition were developed by the researcher based on the pesticide materials in use in the Ohio PAT program (Bohmont, 1990) and information in the core package. The form used for these tests was an objective multiple choice exam. Two instruments (parallel form) containing different questions, but all measuring the same domains, were used for the study. The study used the Newcomb & Trefz model of cognition (1987). The interview schedule developed by Bhardwaj (1989) was used to collect data that measured the intended level of cognition at which the PAT instructors planned to deliver the program. The interview schedule was also used to gather information on lesson and evaluation plans.

Validity and Reliability

To ensure that the tests measure what they were supposed to measure, validity for the instruments was established. Content, relevance, simplicity and perceived time necessary to complete the examination were established by a panel of experts that consisted of two experts in cognition research and three technical experts in pesticide application. Improvements in the instruments were made based on their critiques and recommendations. The questionnaires were pretested with 21 subjects who did not participate in the final study. Coefficient alpha reliabilities were calculated for all levels of cognition before and after selecting the 40 questions used for the study, and reliability ranged from .65 to .85. Inter-rater reliability was calculated for the interview schedule and was .89.

Data Collection

Data for this study were collected between December 1992 and March 1993. A letter co-signed by the adviser and copied to the Associate Director of the OCES and Ohio State University Extension officials was sent to all county agricultural agents conducting core PAT programs. The letter requested their participation in the study. The researcher administered the examinations with the support of the agents. Both pretest and posttest data were collected during the training session. A face-to-face interview using a tape recorder and an interview schedule was employed by the researcher to obtain responses of the agents about their intended level of cognition. Intended cognition level responses were recorded and transcribed based on interviews with the instructors when they were asked "what is the objectives of the program?" Responses were then categorized as:

Remembering level responses: To remember basic facts taught in the training program in order to pass certification exam. To make them know the health protection regulations.

Processing level responses: Be able to understand; adopt first aid steps. To reduce the cost of production. Be able to apply basic principles of dealing with pesticide drift.

Creating level responses: To be able to detect. To determine the appropriateness of a pesticide or protective clothing.

Evaluation level responses: Reduce the cost of pesticide application. To know the benefits obtained from a chosen pesticide or production technique.

Data Analysis

Data were analyzed using the Statistical Package for the Social Science PC+ (SPSSx-user's guide, 1985) at The Ohio State University. The study utilized the descriptive statistics of frequencies, means, percentages, and standard deviations. The Pearson product moment correlation coefficient was used to determine the nature of the relationships between achievement and the independent variables. Davis' scale (1971) was used to describe the magnitude of association found between achievement and the independent variables.

Findings

Table 1 showed that the most frequently intended level of instruction was at the remembering level of cognition, followed by the evaluating level.

Twenty questions were used to collect data regarding the prior knowledge of the participants in the core area. Thus, five questions existed for each cognition level. Each question carried 1 point. Five points could have been scored by a participant that answered correctly all the questions in each cognition level and 20 points could have been scored by a participant that answered correctly all the questions in the four cognition levels. A maximum of 755 points could have been scored by the 151 participants on each cognition level of the prior knowledge (pretest) exam. Table 2 showed that the highest score, 555 points (74%), on the pretest was at the processing level. The next highest was on the evaluating level, 545 (72%), and followed by the remembering level with 501 (66%).

Twenty questions were used to assess the actual level of cognition achieved by the participants in the PAT program. Thus, five questions existed for each cognition level. Each question carried 1 point. Five points could have been scored by a participant that answered correctly all the questions in each cognition level and 20 points could have been scored by a participant that answered correctly all the questions in the four cognition levels. A maximum of 755 points could have been scored by the 151 participants on each cognition level of the posttest exam. Table 3 showed that of 755 possible points to be scored by participants in each cognition level in the posttest exam, the highest score, 587 (78%), was on the remembering level of cognition. The next highest was the processing level score of 561 (74%). Thus, participants' scores decreased as the level of cognition increased.

Learning (achievement) of participants was measured as the sum of the mean of the raw score of the participants in the actual levels of cognition (posttest) exam minus the sum of the mean of the raw score of participants in the prior knowledge (pretest) exam. Achievement of participants was used as the dependent variable for this study. Table 4 indicated that participants achieved most at the lowest level of cognition (remembering level) followed by the creating level of cognition. Prior knowledge of participants was higher than their achieved level of cognition in the PAT program at the evaluating level. Overall, the mean gain (raw score) achieved by the participants in the PAT program was .19.

A negative, very strong relationship was found between the learning of the participants and their prior knowledge (pretest) of pesticide application (r= -.71). A negative, low relationship was found between the learning of the participants and the intended cognition level of instruction (r-.10). A positive, very strong relationship (r=.74) was found between the learning of the participants and their achieved level of cognition in the PAT program

Conclusions

Based on the interview schedule, the pre- and posttest exams, the county agricultural agents who participated in this study intended to deliver the program primarily at the remembering (25%) and evaluation (21%) levels. The participants in this study learned primarily at the remembering level (3.89). This indicated that the county agents who intended to delivered the program at the lowest level actually delivered as they intended and those who intended to deliver the program at the higher cognition levels actually delivered primarily at the lower levels.

Table 1
Intended Levels of Instruction at which the Instructors Planned to Deliver the PAT Program

Cognition Level	Frequency	Percent
Remembering (R)	7	25
Processing (P)	4	14
Creating (C)	3	11
Evaluating (E)	6	21
R + P	3	11
R + P + C	2	7
R + P +C + E.	3	11
Total	28	100

Table 2
PRIOR KNOWLEDGE OF PARTICIPANTS IN THE CORE AREA IN THE OHIO PAT PROGRAM ACROSS COGNITION LEVELS

	R		P		C		E	
	Score	%	Score	%	Score	%	Score	%
	102	68	110	73	135	89	104	68
	56	37	110	73	121	80	111	74
	126	83	117	76	76	50	115	76
	88	58	112	74	101	6	95	63
	129	85	106	70	31	21	120	80
		Av. %		Av. %		Av. %		Av. %
Total	501.00	66	555.00	74	464.00	61	545.00	72
Mean	3.12		3.68		3.07		3.61	
SD	1.26		1.36		1.01		1.24	

Notes:
N = 151
R = Remembering P = Processing C = Creating E = Evaluating.
Column figures represent the total points scored by the participants in each cognition level.

Based on the findings from this study, it may be concluded that participants learned in the PAT program primarily at the remembering level which involved the ability of the participants to memorize and recall simple, concrete facts and definitions taught in the PAT program. Some counties' participants learned little in the PAT program at the creating and evaluating levels. Newcomb and Trefz (1987) indicated that the creating and evaluating levels: (1) required the ability of the instructors to combine pieces of information provided in the program in a form that is new to the participants, (2) required the participants to be able to think independently and to make independent self-

Table 3
ACTUAL LEVELS OF COGNITION ACHIEVED BY PARTICIPANTS IN THE OHIO PAT PROGRAM

	R		P		C		E	
	Score	%	Score	%	Score	%	Score	%
	136	90	127	84	79	52	48	32
	84	57	98	65	125	83	94	62
	119	79	108	72	103	68	103	68
	127	84	116	77	59	39	93	62
	121	80	12	74	125	83	116	77
		Av. %		Av. %		Av. %		Av. %
Total	587.00	78	561.00	74	491.00	65	454.00	60
Mean	3.89		3.72		3.25		3.01	
SD	1.14		1.20		1.16		1.28	

Notes:
N = 151
R = Remembering P = Processing C = Creating E = Evaluating.
Column figures represent the total points scored by the participants in each cognition level.

Table 4
MEAN ACHIEVEMENT MEASURED BY THE DIFFERENCE BETWEEN PRE- & POSTTEST SCORES OF PARTICIPANTS IN THE PAT PROGRAM

	Means		
Cognition Level	Pretest	Posttest	Difference
Remembering level	3.32	3.89	.57
Processing level	3.68	3.72	.04
Creating level	3.07	3.25	.18
Evaluating level	3.61	3.01	-.60
Total	13.68	13.87	.19

Note: N = 151

expression, and (3) involved the ability of the participants to make a judgement or critical evaluation for a given set of information given in the PAT program.

Recommendations

Based on the findings of this study and the literature on cognition and adult education, the following recommendations are made for these groups of audiences: the county extension agents, the Ohio Cooperative Extension Service (OCES), the Ohio Department of Agriculture (ODA), and Environmental Protection Agency (EPA).

The county extension agents should become familiar with the levels of cognition such as Bloom's taxonomy or the Newcomb & Trefz model by attending workshops on cognition. Before the agents can teach for higher order cognition, they must possess an understanding of the cognitive levels. The agents should aspire to deliver the PAT program at the higher levels of cognition so as to raise the achievement of participants in the PAT program.

This study supported the recommendation by Ismail (1992) about hiring county agricultural agents. He recommended that, when hiring county agricultural agents, OCES should hire candidates who have knowledge of cognition. Henderson (1988) noted that persons who have knowledge of cognition and who combine their knowledge and experiences to teach will help improve the cognitive, problem solving skills of participants, and will bring the most up-to-date cognitive knowledge to their participants.

Since the ODA is responsible for testing participants in the PAT program, they should attend workshops on developing tests for higher cognitive levels. Agricultural agents should be involved in developing the examination used for certification with specialists in cognition and in tests and measurements. ODA should expect the OCES and the PAT program instructors to have a

TABLE 5
RELATIONSHIP AMONG THE ACHIEVEMENT OF PARTICIPANTS AND THE INDEPENDENT VARIABLES

Independent Variable	Achievement
Intended cognition level of instruction	-.10
Prior knowledge of the participants	-.71
Actual level of cognition reached by the participants	.74

N = 151

knowledge of cognitive levels. They should provide materials on either Bloom's taxonomy or the Newcomb & Trefz model of cognition to the county extension agents who teach the PAT program.

The EPA should emphasize the design and methods of delivering the PAT program to include cognitive levels. This should promote higher learning (achievement), ethical decision making, and problem solving among the participants.

Implications

Based on the information provided by the instructors of the PAT program during the interview, the findings of this study indicated four main implications.

Lack of assessment of the prior knowledge of the students. The instructors of the PAT program indicated that there was a mixture of participants with various levels of experience in pesticide application. The study clearly indicated that the prior knowledge of the participants in some counties were higher than the actual level of knowledge achieved in the PAT program in other counties. Svinicki, 1993; Thomas and Englund (1990); Rogers (1988); Even (1987); Wang and Walbery (1985) emphasized the powerful impact that prior knowledge has upon current learning and cognition.

PAT instructors did not tend to conduct an assessment of participants' level of prior knowledge before beginning instruction. Incorporating into their style of teaching information regarding their participants' prior knowledge and learning would be helpful to PAT instructors in improving the learning (achievement) of the participants.

Lack of Evaluation. Although a specific objective of the study was not to examine evaluation, interview schedule information clearly indicated that PAT instructors did not conduct formative and/or summative evaluations. When asked whether an evaluation or assessment would be conducted before or after the PAT program, the instructors indicated that no evaluation or assessment would be conducted. Formative evaluation should be conducted during the program to ensure that the program is proceeding in the desired direction. Effective summative evaluation should be conducted at the end of the program to determine whether or not the program has reached the objectives that were intended in the planning process.

Lack of lesson plans. Although a specific objective of the study was not to examine lesson planning, interview schedule information clearly indicated a lack of lesson planning by instructors. When the instructors were asked if they had lesson plans, they indicated that, basically, they used no lesson plans. The agents believed in developing lesson plans but depended on the video tapes provided by The Ohio State University.

Learning. The PAT instructors indicated that the purpose of the PAT program was primarily to prepare pesticide applicators for certification. Reducing the number of violation reports and investigations made by the ODA Pesticide Regulation Section requires that participants learn at higher cognition levels. Certification is important, but there is a greater chance of further reducing the number of pesticide accidents by teaching and learning at higher cognitive levels. Learning at a higher cognitive level depends upon active involvement of the learner in the teaching and learning interaction. Participants learned primarily at the lowest level. Little was learned at the higher levels of cognition. The learning implication supported the studies by Whittington (1991), and Ismail (1992).

Recommendations for Further Study

1. The study needs to be replicated in different counties and states, with different agents and participants.

2. Research should be conducted to assess the cognition level of instructors who deliver the PAT program and determine its relationship to the learning of participants.

3. Research should be conducted to assess the highest cognition level at which PAT instructors deliver the PAT program and its relationship to the learning and level of cognition achieved by participants in the PAT program.

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SUMMARY OF RESEARCH SERIES

Increasingly complex problems and issues faced by agriculturist require more sophisticated problem solving skills. Recently, research in extension education has moved from emphasis on information dissemination to a focus on adult learning and cognition. In addition to disseminating information, extension personnel should teach their clientele how to further develop, use, and improve their cognitive skills in order to become better thinkers, problem solvers, and decision makers. The purpose of this study was to determine the learning (achievement) of the participants in the Ohio private pesticide application training program by assessing the intended level of cognition of instruction and the actual cognition level achieved by the participants in the training program. It should be of interest to extension specialists and other adult educators who are designing, developing, and delivering training programs.

This summary is based on a dissertation by Daniel Okoro under the direction of Larry E. Miller. Daniel Okoro was a graduate student in the Agricultural Education Department at The Ohio State University. Dr. Larry E. Miller is a Professor, Department of Agricultural Education, The Ohio State University. Special appreciation is due to Matt Baker, California State Polytechnic University; Carla Kirts, University of Alaska; Thomas R. Stitt, Southern Illinois University; and Richard Clark, The Ohio State University for their critical review of the manuscript prior to publication.

Research has been an important function of the Department of Agricultural Education since it was established in 1917. Research conducted by the Department has generally been in the form of graduate theses, staff studies, and funded research. It is the purpose of this series to make useful knowledge from such research available to practitioners in the profession. Individuals desiring additional information on this topic should examine the references cited.

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